IN THE CLAIMS

We claim:

1. A single wafer wet/dry cleaning apparatus comprising:

a transfer chamber having a wafer handler contained therein;

a first single wafer wet cleaning module directly coupled to said transfer chamber; and

a first single wafer ashing module directly coupled to said transfer chamber.

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2. The apparatus of claim 1 further comprising:

a first wafer cassette coupled to said transfer chamber; and

a second wafer cassette coupled to said transfer chamber.

3. The apparatus of claim 1 further comprising:

a second single wafer wet cleaning module directly coupled to said transfer chamber; and

a second single wafer ashing module directly coupled to said transfer chamber.

4. The apparatus of claim 1 wherein said wafer handler is a dual blade robot on a single track in said transfer chamber.

5. The apparatus of claim 1 wherein said single wafer wet cleaning module comprises:

means for holding said wafer;

means for provide acoustic energy to a non-device side of said wafer; and

means for flowing a liquid onto the device side of said wafer.

6. A method of cleaning a residue or a photoresist layer from a wafer comprising:

transferring from a wafer cassette a wafer having a residue thereon into a transfer chamber having robot contained therein;

transferring said wafer from said transfer chamber into an ashing module coupled to said transfer chamber;

ashing said wafer in said ashing module to form an ashed wafer;

transferring said ashed wafer from said ashing module to said transfer chamber;

transferring said ashed wafer from said transfer chamber to a wet processing module coupled to said transfer chamber;

cleaning said ashed wafer with a cleaning solution in said wet processing chamber to form a cleaned and ashed wafer;

transferring said cleaned and ashed wafer from said cleaning module to said transfer chamber; and

removing said cleaned and ashed wafer from said transfer chamber.

7. The method of claim 6 wherein said ashing comprises:

exposing said wafer to an energized cleaning gas; and

before, during or after exposing said wafer to said energized cleaning glass, exposing the said wafer to an energized treating gas comprising a halogen species and a hydrogen species.

8. The method of claim 7 wherein the cleaning gas comprises:

a stripping gas comprising one or more of O_2, N_2, H_2O, NH_3, CF_4, C_2F_6, CHF_3, $C_3H_2F_6$, $C_2H_4F_2$, and CH_3F provided under process conditions selected to at least partially remove said residue when said residue is remnant resist material.

9. The method of claim 6 wherein said cleaning comprises:

transmitting sonic energy to a non-device side of said wafer while flowing said cleaning solution onto said wafer device side.

10. The method of claim 7 wherein said cleaning comprises:

transmitting sonic energy to a non-device side of said wafer while flowing said cleaning solution onto said wafer device side.

11. An apparatus for atmospheric and sub-atmospheric processing of a wafer comprising:

an atmospheric transfer chamber having first a wafer handler contained therein;

a sub-atmospheric transfer chamber having a second wafer handler contained therein;

a first load lock coupled to said sub-atmospheric transfer chamber and to said atmospheric transfer chamber;

a first atmospheric processing module coupled to said atmospheric transfer chamber; and

a first sub-atmospheric processing module coupled to said sub-atmospheric transfer chamber.

12. The apparatus of claim 11 wherein said first atmospheric processing module is selected from the group consisting of a wet cleaning module and a metrology module.

13. The apparatus of claim 11 wherein said first sub-atmospheric chamber is selected from the group consisting of:

an etch module, a CVD deposition module, an ashing module, a sputter module, an oxidation module, and an anneal module.

14. The apparatus of claim 11 further comprising a second load lock coupled between said atmospheric transfer chamber and said sub-atmospheric transfer chamber.

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15. The apparatus of claim 11 wherein said first and said second load locks are single wafer load locks.

16. The apparatus of claim 11 further comprising, a wafer cassette coupled to said atmospheric transfer chamber for providing wafers to be loaded into said atmospheric transfer chamber.

17. A method of processing a wafer comprising:

transferring a wafer from a wafer cassette into an atmospheric transfer chamber;

transferring said wafer from said atmospheric transfer chamber into a load lock coupled to said atmospheric transfer chamber;

reducing the pressure in said load lock to a sub-atmospheric pressure;

transferring said wafer from said load lock into a sub-atmospheric transfer chamber coupled to said load lock;

transferring said wafer from said sub-atmospheric transfer chamber into a sub-atmospheric process chamber coupled to said sub-atmospheric transfer chamber;

processing said wafer in said sub-atmospheric process chamber to produce a sub-atmospheric processed wafer;

transferring said sub-atmospheric processed wafer from said sub-atmospheric process chamber to said sub-atmospheric transfer chamber;

transferring said sub-atmospheric processed wafer from said sub-atmospheric transfer chamber into a load lock at said sub-atmospheric pressure;

raising the pressure in said load lock to atmospheric pressure;

transferring said sub-atmospheric processed wafer from said load lock to said atmospheric transfer chamber;

transferring said sub-atmospheric processed wafer from said atmospheric transfer chamber to an atmospheric process chamber coupled to said atmospheric transfer chamber;

processing said sub-atmospheric processed wafer in said atmospheric process chamber to produce a sub-atmospheric processed and a atmospheric processed wafer;

transferring said sub-atmospheric processed and said atmospheric processed wafer from said atmospheric processing chamber to said atmospheric transfer chamber; and

removing said sub-atmospheric processed and said atmospheric processed wafer from said atmospheric transfer chamber.

18. An apparatus for etching and cleaning a wafer comprising:

an atmospheric transfer chamber having a first wafer handler contained therein;

a sub-atmospheric transfer chamber having a second wafer handler contained therein;

a first load lock coupled to said sub-atmospheric transfer chamber and to said atmospheric transfer chamber;

a single wafer wet cleaning module directly coupled to said atmospheric transfer chamber; and

a etch module couple to said sub-atmospheric transfer chamber.

19. The apparatus of claim 18 further comprising an integrated particle monitoring tool coupled to said atmospheric transfer chamber.

20. The apparatus of claim 18 further comprising an ashing module coupled to said atmospheric transfer chamber.

21. The apparatus of claim 18 further comprising a CD measurement tool coupled said sub-atmospheric transfer chamber.

22. The apparatus of claim 20 further comprising a second ashing module coupled to said sub-atmospheric transfer chamber.

23. The apparatus of claim 18 further comprising a second etch module coupled to said sub-atmospheric transfer chamber.

24. The apparatus of claim 19 further comprising a controller for controlling said ashing module and for controlling said wet cleaning module wherein said controller includes stored instructions for determining the operation of said ashing module or said wet cleaning module depending upon results in said integrated particle monitoring tool.

25. The apparatus of claim 21 further comprising a controller for controlling the operation of said critical dimension monitoring tool and for controlling the operation of said etch module and wherein said computer includes stored information for controlling the operation of said etch module depending upon measurement taken by said critical dimension monitoring tool.

26. A method of processing a wafer comprising:

transferring a wafer having a patterned photoresist layer formed on a thin film from a wafer cassette into an atmospheric transfer chamber;

transferring said wafer from said atmospheric transfer chamber into a load lock coupled to said atmospheric transfer chamber;

reducing the pressure in said load lock to a sub-atmospheric pressure;

transferring said wafer from said load lock into a sub-atmospheric transfer chamber coupled to said load lock;

transferring said wafer from said sub-atmospheric transfer chamber into an etch chamber coupled to said sub-atmospheric transfer chamber;

etching said thin film in alignment with said patterned photoresist layer in said etch chamber at a sub-atmospheric pressure to form an etched wafer;

transferring said etched wafer from said etch chamber to said sub-atmospheric transfer chamber;

transferring said etched wafer from said sub-atmospheric transfer chamber to an ashing chamber coupled to said sub-atmospheric transfer chamber;

ashing said etched wafer in said ashing chamber to remove said patterned photoresist layer;

transferring said etched and ashed wafer from said ashing chamber to said sub-atmospheric transfer chamber;

transferring said etched and ashed wafer from said sub-atmospheric transfer chamber into a load lock at said sub-atmospheric pressure;

raising the pressure in said load lock to atmospheric pressure;

transferring said etched and ashed wafer from said load lock to said atmospheric transfer chamber;

transferring said etched and ashed wafer from said atmospheric transfer chamber to a wet cleaning chamber coupled to said atmospheric transfer chamber;

cleaning said etched and ashed wafer in said wet cleaning chamber to produce an etched, ashed, and cleaned wafer;

transferring said etched, ashed, and cleaned wafer from said wet cleaning chamber to said atmospheric transfer chamber; and

removing said etched, ashed, and cleaned processed wafer from said atmospheric transfer chamber.

27. The method of claim 26 wherein said thin film comprises a metal film.

28. The method of claim 26 wherein said thin film comprises a stack of metal films.

29. The method of claim 28 wherein said stacked metal film comprises an anti-reflective layer, a main conductive layer, and a barrier layer.

30. The method of claim 26 wherein said thin film is a dielectric film.

31. The method of claim 30 wherein said dielectric film is selected from the group consisting of silicon dioxide, silicon oxynitride, SiOF, BPSG, undoped silicon pass and organic dielectrics.

32. The method of claim 26 wherein said ashing comprises:

exposing said wafer to an energized cleaning gas; and

before, during or after exposing said wafer to said energized cleaning gas, exposing said wafer to an energized treating gas comprising a halogen species and a hydrogen species.

33. The method of claim 32 wherein said cleaning gas comprises:

a stripping gas comprising one or more of O2, N2, H2O, NH3,CF4, C2F6, CHF3, C3H2F6, C2H4F2, and CHF3 provided under pressure conditions selected to at least partially remove said residue when said residue is remnant resist material.

34. The method of claim 26 wherein said cleaning comprises:

transmitting sonic energy to a nondevice side of said wafer while flowing said cleaning solution on said wafer device side.

35. The method of claim 26 wherein said cleaning comprises:

transmitting sonic energy to a nondevice side of said wafer while flowing said cleaning solution onto said device side.

36. The method of claim 26 further comprising:

prior to transferring said wafer from said atmospheric transfer chamber into said load lock, transferring said wafer into a CD measurement tool, and determining whether or not the CD measurements are in compliance.

37. The method of claim 36 wherein if said CD measurements are not in compliance transferring said wafer into a ashing chamber coupled to said atmospheric transfer chamber, and removing said photoresist mask in said ashing chamber.

38. The method of claim 26 further comprising the step of:

prior to etching said thin film in said etch chamber, trimming said photoresist mask.

39. The method of claim 38 wherein said trim utilizes oxygen plasma.

40. The method of claim 26 wherein after ashing said wafer, passivating said substrate to a passivating gas which inactivates corrosive etchant residue.

41. The method of claim 26 further comprising the step of:

after ashing said wafer in said ashing chamber, transferring said wafer from said atmospheric transfer chamber into a CD measurement tool, and checking the critical dimensions of said etched wafer.

42. The method of claim 26 wherein after wet cleaning said etched and ashed wafer transferring said etched, ashed and cleaned wafer into a critical dimension monitoring tool coupled to said atmospheric transfer chamber and checking said critical dimensions of said etched film.

43. The method of claim 26 wherein said thin film is a dielectric film, and further comprising after transferring said etched, ashed and cleaned wafer from said wet cleaning chamber to said atmospheric transfer chamber;

transferring said etched, ashed and cleaned wafer from said atmospheric transfer chamber into a load lock coupled to said atmospheric transfer chamber;

reducing the pressure of said load lock to a sub-atmospheric pressure;

transferring said wafer from said load lock into a sub-atmospheric transfer chamber coupled to said load lock;

transferring said wafer from said sub-atmospheric transfer chamber into a metal deposition chamber coupled to said sub-atmospheric transfer chamber;

depositing a metal film in said deposition chamber coupled to said sub-atmospheric transfer chamber.

44. An apparatus for the formation of an electrode comprising:

an atmospheric transfer chamber having a first wafer handler contained therein;

a sub-atmospheric transfer chamber having a second wafer handler contained therein;

a first load lock coupled to said sub-atmospheric transfer chamber and to said atmospheric transfer chamber;

a wet cleaning module coupled to said atmospheric transfer chamber;

a single wafer thermal process module coupled to said sub-atmospheric transfer chamber; and

a polysilicon deposition module coupled to said sub-atmospheric transfer chamber.

45. The apparatus of claim 44 further comprising an integrated particle monitoring tool coupled to said atmospheric transfer chamber.

46. The apparatus of claim 44 further comprising an integrated thickness measurement tool couple to said atmospheric transfer chamber.

47. The method of claim 45 further comprising an integrated thickness measurement tool coupled to said atmospheric transfer chamber.

48. The apparatus of claim 44 further comprising a second single wafer thermal process tool coupled to said sub-atmospheric transfer chamber.

49. The apparatus of claim 44 further comprising a second load lock coupled to said atmospheric transfer chamber and to said sub-atmospheric transfer chamber.

50. The apparatus of claim 45 further comprising a computer controller for controlling said silicon deposition chamber, said thermal process chamber and said single wafer wet cleaning chamber, and said controller storing operation parameters for the operation of wet cleaning chamber depending upon results from a measure taken in the integrated particle monitoring tool.

51. The apparatus of claim 46 further comprising a computer for controlling the operation of said thermal process chamber, and said polysilicon deposition chamber and wherein said controller stores information for determining the process parameters of said polysilicon deposition chamber and/or said thermal oxidation chamber depending upon results measured in said integrated thickness measuring tool.

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52. A method of forming a transistor comprising:

transferring a monocrystalline silicon substrate from a wafer cassette into an atmospheric transfer chamber;

transferring said a monocrystalline silicon substrate from said atmospheric transfer chamber to a wet cleaning chamber coupled to said atmospheric transfer chamber;

cleaning said monocrystalline silicon substrate with a cleaning solution in said cleaning apparatus;

transferring said cleaned monocrystalline silicon substrate from said cleaning chamber to said atmospheric process chamber;

transferring said a monocrystalline silicon substrate from said atmospheric transfer chamber into a load lock coupled to said atmospheric transfer chamber;

reducing the pressure in said load lock to a sub-atmospheric pressure;

transferring said a monocrystalline silicon substrate from said load lock into a sub-atmospheric transfer chamber coupled to said load lock;

transferring said wafer from said sub-atmospheric transfer chamber into an oxidation chamber coupled to said sub-atmospheric transfer chamber;

oxidizing the monocrystalline silicon substrate to a monocrystalline silicon substrate to form a dielectric film on said monocrystalline silicon substrate in said oxidation chamber;

transferring said oxidized monocrystalline silicon substrate from said oxidation chamber to said sub-atmospheric transfer chamber;

transferring said oxidized wafer from sub-atmospheric transfer chamber to a polysilicon deposition chamber coupled to said sub-atmospheric chamber;

depositing a polysilicon film on said dielectric film formed on said monocrystalline silicon substrate in said polysilicon deposition chamber;

transferring said wafer with said deposited polysilicon film from said polysilicon deposition chamber to said sub-atmospheric transfer chamber;

transferring said oxidized and polysilicon deposited wafer from said sub-atmospheric transfer chamber into a load lock at said sub-atmospheric pressure;

raising said pressure in said load lock to atmospheric pressure;

transferring said oxidized and polysilicon deposited wafer from said load lock to said atmospheric transfer chamber; and

removing said oxidized and polysilicon deposited wafer from said atmospheric transfer chamber.

53. A method of stripping a silicon nitride film from a wafer comprising:

transferring a wafer having a silicon nitride film thereon into an atmospheric transfer chamber;

tranferring said wafer from said atmospheric transfer chamber into a load lock coupled to said atmospheric transfer chamber;

reducing the pressure in said load lock to a sub-atmospheric pressure;

transferring said wafer from said load lock into said sub-atmospheric transfer chamber coupled to said load lock;

transferring said wafer from said sub-atmospheric transfer chamber into an etch module coupled to said sub-atmospheric transfer chamber;

etching said silicon nitride film from said wafer in said etch module coupled to said sub-atmospheric process chamber;

transferring said silicon nitride stripped wafer from said etch module to said sub-atmospheric transfer chamber;

transferring said silicon nitride etched wafer from said sub-atmospheric transfer chamber into a load lock at said sub-atmospheric pressure;

raising the pressure in said load lock to atmospheric pressure;

transferring said silicon nitride etched wafer from said load lock to said atmospheric transfer chamber;

transferring said silicon nitride etched wafer from said atmospheric transfer chamber to a wet cleaning module coupled to said atmospheric transfer chamber; and

cleaning said silicon nitride etched wafer in said wet cleaning chamber to produce a silicon nitride etched and cleaned wafer.

54. The method of claim 53 wherein said wet cleaning comprises:

transmitting sonic energy to a nondevice side of said wafer while flowing a solution on said wafer device side.

55. The method of claim 53 further comprising after cleaning said wafer in said wet cleaning module, transferring said wafer to a particle monitoring tool coupled to said atmospheric transfer chamber, and checking said surface of said wafer for particles or residue.

56. The method of claim 55 further comprising utilizing said information from said particle monitoring tool to alter the silicon nitride strip parameters and/or the wet cleaning parameters for processing of subsequent wafers.

57. An apparatus for the photolithography processing of a wafer comprising:

a single wafer wet cleaning module;

a photolithography module; and

a transfer chamber having a wafer handling device contained therein, said wafer transfer chamber directly coupled to said single wafer wet cleaning module and to said photolithography module.

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58. The apparatus of claim 57 wherein said single wet cleaning module comprises:

a plate having an acoustic energy generating device coupled to a first side;

means for positioning a wafer horizontally above a second side of said plate opposite said first side; and

means for applying a cleaning solution onto said plate second side.

59. The apparatus of claim 58 wherein said means for providing fluid to said plate second side comprises an aperture formed through said plate and a conduit coupled to said aperture for providing said cleaning solution through said aperture to said plate second side.

60. The apparatus of claim 57 wherein said photolithography module comprises:

a photoresist application station for applying a photoresist film on a wafer;

a soft bake station for heating said photoresist film; and

a exposure station for exposing said photoresist to radiation.

61. The apparatus of claim 60 wherein said wafer handling device is connected to a linear track in said transfer chamber and wherein said wafer handling device can access said wet clean module, said spin station, said soft bake station, and said exposure station.

62. The method of claim 61 wherein said single wafer cleaning module is adjacent to said spin station, wherein said spin station is adjacent to said soft bake station, wherein said soft bake station is adjacent to said stepper station, and wherein said stepper station.

63. The apparatus of claim 61 wherein said single wafer clean module is adjacent to said spin station on a first side and is adjacent to said soft bake station on a second side opposite said first side.

64. The apparatus of claim 61 wherein said single wafer clean module is adjacent to said soft bake station on a first side and is adjacent to said exposure station on said second side opposite said first side.

65. The apparatus of claim 60 wherein said transfer chamber includes a filter for filtering amine and ammonia vapors from the ambient in said transfer chamber.

66. A method of photolithographic processing of a wafer comprising:

forming a photoresist film on a first side of a wafer having said first side and a second side opposite said first side;

cleaning said wafer second side with a solution while said photoresist is on said wafer first side; and

exposing said photoresist film on said wafer first side to radiation after cleaning said wafer second side with said solution.

67. The method of claim 66 wherein said cleaning of said wafer second side comprises:

horizontally positioning said wafer second side adjacent to and spaced-apart from a horizontal plate; and

providing said solution between said plate and said wafer second side.

68. The method of claim 67 further comprising applying acoustic energy to a second side of said plate while flowing said fluid between said plate and said wafer second side.

69. The method of claim 68 wherein said acoustic energy is applied in a direction normal to said wafer second side.

70. The method of claim 69 wherein said acoustic energy is applied at a frequency of approximately 925 KHz.

71. The method of claim 66 wherein said wafer frontside is kept dry while cleaning said wafer backside.

72. The method of claim 66 wherein said wafer first side has a plurality of patterns formed thereon.

73. A method of photolithographicly processing a wafer comprising:

placing a wafer into a transfer chamber;

transferring said wafer from said transfer chamber into a single wafer wet clean module directly coupled to said transfer chamber;

cleaning said wafer backside in said single wafer cleaning module to produce a backside cleaned wafer;

transferring said backside cleaned wafer from said single wafer clean module to said transfer chamber;

transferring said backside cleaned wafer from said transfer chamber to a photoresist application module directly coupled to said transfer chamber;

applying photoresist to said wafer front side opposite said backside in said photoresist application module to produce a photoresist deposited wafer;

transferring said photoresist deposited wafer from said photoresist application module to said transfer chamber;

transferring said photoresist deposited wafer from said transfer chamber to an exposure station coupled directly to said transfer station; and

exposing said photoresist on said photoresist deposited wafer to radiation to produce a radiation exposed photoresist film on said photoresist deposited wafer.

74. The method of claim 73 wherein said cleaning of said wafer backside comprises:

horizontally positioning said wafer backside adjacent to and spaced-apart from a horizontal plate; and

flowing a fluid between said horizontal plate and said wafer second side.

75. The method of claim 74 further comprising applying acoustic energy to a second side of said horizontal plate while flowing said fluid between said plate and said wafer second side.

76. The method of claim 75 wherein said acoustic energy is applied in a direction normal to said wafer second side.

77. The method of claim 76 wherein said wafer frontside is kept dry while cleaning said wafer backside.

78. The method of claim 76 further comprising:

cleaning said wafer frontside by flowing a second fluid onto said wafer front side while providing said fluid between said plate and said wafer second side.

79. The method of claim 73 further comprising filtering amine and ammonia vapors from said transfer chamber.